Environmental Science and Policy 93 (2019) 221–231

Contents lists available at ScienceDirect

Environmental Science and Policy

journal homepage: www.elsevier.com/locate/envsci

An institutional analysis method for identifying policy instruments facilitating the adaptive governance of drought

Margot A. Hurlbert[a,*], Joyeeta Gupta[b]

[a] Johnson-Shoyama Graduate Shool of Public Policy, University of Regina, Regina, Saskatchewan, S4S 0A2, Canada
[b] UNESCO-IHE Institute for Water Education, Delft, The Netherlands and Governance and Inclusive Development, Amsterdam Institute for Social Science Research, University of Amsterdam, Amsterdam, the Netherlands

ABSTRACT

Situate within new institutionalism literature, this paper builds a complex system model of institutional analysis for adaptive governance. This model combines Young's institutional environmental analysis method (2005), elements of subsequent environmental governance projects models, and ideas of multiple institutional levels and drivers. By applying the model, policy instruments are identified that build agricultural producer livelihoods improving their adaptive capacity to respond to climate change and drought. In relation to three case studies in Canada, Chile, and Argentina, policy instruments that deliver co benefits to improve agricultural producer technological, social, human, economic, and natural capital include crop insurance, income stabilization instruments, farm water infrastructure grants, environmental farm planning (improving soil management), drought predictions and alerts, and watershed management plans. Missing instruments included international instruments of mitigation and adaptation through disaster risk reduction, climate change mitigation instruments, and involvement of people in review and assessment of instruments in the context of climate change (iterative anticipatory governance). The model allows for instrument redesign through interdisciplinary interaction with the agricultural and policy community, reviewing climate change scenarios, identifying missing and weak instruments and dimensions of adaptive governance.

1. Introduction

In many areas of the world climate variability and change are resulting in increased incidence and intensity of high temperature extremes causing drought, and these events may become more severe in the future (IPCC, 2014). To address wicked, complex problems,[1] such as climate change and drought, interdisciplinary science and integrative research methods are required (Repko and Szostak, 2017). However, research methods that integrate interdisciplinary work have eluded the majority of research projects (Roy et al., 2013). It is necessary that interdisciplinary environmental research be integrated by formulating common meanings around shared vocabularies (Bracken and Oughton, 2006; Matthews and Jones, 2008) and with a focus on issues of scale (space and time) (Buizer et al., 2011). Such research will allow environmental problems to be seen in a larger context, in a comprehensive manner (Brewer, 1999) and enables the identification of solutions to address climate change and drought, a complex, wicked problem in regard to agricultural producers.

Nations with well developed institutional governance systems are better able to adapt and deal with risks of future climate change (IPCC, 2001) as these systems positively influence the adaptive capacity of agricultural producers (Hurlbert and Diaz, 2013) and help protect the livelihood capitals of people (de Haan and Zoomer, 2005d). Agricultural producers with strong livelihood capitals (economic, human, social and natural) are less vulnerable and have more adaptive capacity to meet the impacts of climate change (Moser, 2009). For these reasons, studying governance institutions is important in addressing climate change and improving the adaptive capacity of agricultural producers to respond to climate change and drought. Hence, this paper develops an integrative, interdisciplinary research method to assess how institutions for adaptive governance, and specifically policy instruments,[2] can be assessed and redesigned. The method is illustrated through examples from drought management of farmers in Canada, Argentina, and Chile (Hurlbert and Gupta, 2016; Jiménez Cisneros et al. (2014); See Hurlbert, 2018).

After reviewing the literature on adaptive governance and institutions, the institutional research analysis method for adaptive governance will be developed and illustrated in this paper. The strengths and

* Corresponding author.
E-mail address: margot.hurlbert@uregina.ca (M.A. Hurlbert).

[1] It is a problem that is so complex, it defies complete definition and there can be no final solutions, since any resolution generates further issues, and solutions are not true or false, or good or bad, but the best that can be done at the time (Rittel and Webber, 1973).

[2] Policy instruments are types of institutions that organize specific social relations between the state and those the instrument is addressed to (Lascoumes and Le Gales, 2007), or techniques or tools by which states attempt to attain their goals including stakeholder consultations, legislative rules and norms (Howlett, 2011).

https://doi.org/10.1016/j.envsci.2018.09.017
Received 20 July 2018; Accepted 24 September 2018
Available online 13 November 2018
1462-9011/ © 2018 Elsevier Ltd. All rights reserved.

weaknesses of the research method are recounted and recommendations for its future application made.

2. Adaptive governance and new institutionalism

Adaptive governance[3] has emerged as a theoretical framework of governance that best responds to the uncertain, systemic, complex, and often contested problem of climate change (Dietz et al., 2003; Pahl-Wostl et al., 2013). Adaptive governance constitutes a social function that steers collective behavior toward favourable outcomes and discourages unfavourable outcomes (Young 2017). Linking ecosystem dynamics, resilience, and complexity theory, adaptive governance is the range of political, social, economic, and administrative systems that develop, manage and distribute society's resources in order to promote resilient institutions[4] and social networks in multi-level governance systems[5] through collaborative, flexible and learning based issue management across different scales (Folke et al., 2005; Olsson et al., 2006). In order to build resilience institutions and social networks, adaptive governance focuses on increasing the adaptive capacity of people to deal with uncertainty, surprise and external drivers (Berkes and Folke, 1998).

Adaptive governance entails best practices of governance (Hurlbert and Gupta, 2016) including: 1. Adaptive management that addresses uncertainty through hypothesis testing, monitoring, evaluating and revision of policy based on this process (Foxon et al., 2009); 2. Adaptive co-management, which is community based resource management that replicates adaptive management processes (Plummer, 2009); and 3. Anticipatory governance defined as a decision making framework that uses scenarios of possible futures and revisits decisions when new information is discovered with new scenarios (Quay, 2010). Governance is an important constituent of risk as it often determines whether events of drought become disasters (Auth 2018). Adaptive governance would reduce and manage the risk of climate change and drought, whereas poor and rigid governance would exacerbate this risk. This institutional analysis method aims at assessing if a governance system achieves adaptive governance and provides recommendations for improving adaptive governance.

The core of a governance system include institutional arrangements (Young, 2017). The institution is the unit of analysis of this research method as environmental and public policy is best examined from an institutionalist perspective (Vatn, 2005). An institution is a stable and collective pattern of dealing with basic social functions (such as managing and allocating water resources, or responding to policy problems such as climate change) and is determined by norms, rules, laws, policies, and practices that have a degree of permanency (Homer-Dixon, 1999). Society develops institutions that are informal (e.g. practices) and formal (e.g. organizations) to address policy problems at local, regional, national and global levels. Institutions are both sticky and stable in that they need to be predictable, as well as constantly evolving, as they need to keep changing to address new problems. This change process is based on both assessment of the ability of existing institutions to address societal problems, as well as an assessment of whether these institutions can anticipate the changing nature of problems and the risks that such change brings with them.

This institutional analysis method is situated within the new institutional literature that broadens the definition of governance moving away from focus on monolithic actors of the state (Paavola, 2007). Within the literature of new institutionalism political action is not always calculated, rational and in self interest, but it occurs in accordance with rules and practices that are socially constructed, publicly known, anticipated and accepted (March and Olsen, 2011); dependence on the polity or society. Political action is deemphasized, instead focusing on the interdependence between relatively autonomous social and political institutions (March and Olsen, 1984). Building on the new institutionalism of Young (2002) pragmatic and empirical focus is on rules that are in use and their actual roles in determining outcomes.

This institutional analysis method addresses a weakness in the adaptive governance literature in providing specific methods for application and analysis, probing risk, uncertainty and complexity, and identifying a clear outcome to measure (Auth, 2018). The existing literature creates a variety of methods to analyse governance institutions and policy effectiveness Tudela et al. (2006). However, there is no real comprehensive method for analysing the ability of institutions in specific contexts to deal with uncertain, unstructured problems. There are methods that examine the nature of the problem by descriptively providing a snapshot of the current state of affairs (Stangor, 2010), but such methods are not linked to the analysis of institutions. There are methods to assess institutions (Young et al., 2005; IDGEC, 1998), but these are not linked to how to promote the adaptive capacity of institutions in the context of uncertainty and climate change (Gupta et al., 2010). Methods on adaptive capacity do not use and build on Young's institutional analysis. Most of these methods are not linked to the goal of inclusive development, which focuses on enhancing social wellbeing and environmental sustainability. However, livelihoods approaches used mostly in development studies (Scoones, 2009) focus on human, social, technological, economic and environmental capitals and could help to enrich existing institutional analysis. At the same time, existing livelihoods approaches are not linked to multi-level institutional analysis.

Hence, this paper focuses on the question: How can methods for assessing, analyzing and designing institutions be integrated into a comprehensive assessment method to enhance adaptive capacity to deal with increasingly complex policy problems?

Utilizing a process described by Paavola (2007), the new institutional approach is extended conceptually to environmental governance in the context of climate change and drought. This research focus is on agricultural producers interacting with drought and climate change policy instruments, in the context of multiple drivers, all impacting their livelihood capitals (see section 3). It differs from other applications of new institutionalism that concern common pool resources such as water or pastures (Ostrom, 1990)[6], or one level of governance such as the international level (Young, 2002), or unidirectional causal mechanisms of specific governance institutions (Oberthür and Gehring, 2006), a single method such as discursive analysis (Schmidt, 2011), or a choice between modes of governance (collective choice or market governance) (Norgaard and Liu, 2007) or structures of governance (Dwyer and Hodge, 2016). The focus is on (1) social practice models stemming from anthropology and sociology emphasizing the roles of culture, norms, habits as sources of behavior (Young, 2002) which complement the ethnographic vulnerability analysis that was part of this research; and (2) the interaction of policy instruments as normative structures that influence their use and influence on people (Vatn, 2005).

3. Method

This paper's method builds on Young's institutional analysis method (2005) which also became the centre piece of the International Human Dimensions Programme's (IHDP) Institutional Analysis of Global Environmental Change (IDGEC) project (IDGEC, 1998). Ideas of Ranganathan et al. (2008) and Paavola (2016) surrounding institutions

[3] Also termed experimental governance (Sabel and Zeitlin, 2012).

[4] Resilient institutions are those institutions that have the capacity to persist in the face of change (Folke, 2016).

[5] A governance system is an ensemble of elements performing the function of governance (Young, 2017).

[6] Therefore, models such as Ostrom's Institutional Analysis and Development framework (2010) and Schmid's Structure, Situation and Performance framework (1987) focusing on individual decision making could not be used.

and the interaction of multiple institutional drivers and levels (global, regional, local) in a complex system model are also incorporated.

In assessing policy instruments in a government system, Young et al. (2005) asserts three problems must be addressed: causality, performance, and design. Young argues that it is first important to know whether the policy problem is to some extent caused by institutional failure (the problem of causality). He also asserts a need to understand the various policy instruments that have been developed to address the problem, and whether these instruments are both contextually appropriate and can address the drivers that cause the problem (the problem of performance). Young's analysis also allows for a redesign of policy instruments, taking into account the lessons learnt in the previous steps (the problem of design).

While Young's method focuses on the design and redesign of instruments, IHDP and its successor Future Earth's Earth Systems Governance (ESG) Project (Biermann et al., 2009)[7] argues that the cross-cutting issues including norms and scale need to be accounted for, as well as themes of 'Architecture' (what is the structure of the institution), 'Agency' (who are the actors), and 'Adaptiveness' (how adaptive is the policy). This paper's institutional analysis research method for adaptive governance selects and builds on aspects of both of these foundational sources.[8]

A combination of Young's and the ESG's method was first made by Gupta et al. (2013) such that Young's institutional analysis method was enhanced to take into account multiple levels of governance and allow for an evolutionary analysis. This was tested in relation to an analysis of forests (Gupta et al., 2013). Gupta et al. (2013) took into account that instruments emerge from institutions developed at multiple levels of governance and they are often only able to deal with certain contextual features or certain drivers; in the case of the drivers this depends also on the level and nature of the driver. A local instrument, for example, cannot address a global driver. Smart combinations of policy instruments are required; Gupta et al. allowed for multi-level institutional analysis linking broader contextual variables (e.g. 'drivers') to micro-situational variables (e.g. impact on behaviour of actors). This paper, as depicted in Fig. 1 below, elaborates on Young, ESG, and Gupta et al. (2013).

Other ESG themes and cross-cutting issues are integrated systematically into to this model: (a) social, human, economic, technological, and natural capital as a way to assess the impact of institutions on local livelihoods (Moser, 2009); (b) some dimensions of adaptive capacity including social learning (Gupta et al., 2010; Siebenhuner, 2008) thereby referring to the adaptiveness element of the ESG framework; and (c) the kind of participatory process needed for the redesign stage for anticipatory governance (one of the processes of adaptive governance) (Hurlbert and Gupta, 2015). This latter point implicitly takes account of some of the agency issues that are relevant from the ESG framework. This architecture is evaluated in respect of accountability in step 6, when instrument redesign is employed utilizing the adaptive capacity wheel (Gupta et al., 2010).

The steps below correspond to the number in brackets of each of the boxes appearing in Fig. 1 outlined on Table 1. At the outset, it is necessary to establish the parameters of the research through an identification of what the policy problem is (the gap between a current situation and a more desirable future one (Hoppe, 2011)). This research, focused on vulnerability of agricultural producers in relation to future climate change, and the embedded policy problem of drought.

During the process of defining the research study, as drivers and problems are reviewed and selected, a process of problem framing and definition occurs. How a policy problem is framed informs how policy makers and the public construct meaning around the problem or analyze and respond to the problem (Lebel et al., 2010). Policy framing refers to how a particular problem, or risk, is constructed. "Frames are principles of selection, emphasis and presentation composed of little tacit theories about what exists, what happens, and what matters" (Gitlin, 1980: 6). Implicit in this definition is the social and political construct which articulates that a particular state of affairs is undesirable, that a particular 'risk' to society exists, and that a more desirable future state (in accordance with values, norms, and goals) can be attained by governmental steering (Hisschemöller and Hoppe, 1996). Here critical realism informs the 'reality' that is bound up with the 'perception' (Carroll, 1988: 1) of actors, and specifically those actors with the power to determine the policy agenda (Hisschemöller and Gupta, 1999).

It is here that issues of norms and science (components of architecture and cross cutting themes in the ESG framework (Biermann et al., 2009)) inform this research. Climate change is a policy problem, but can be broken into several smaller embedded problems associated with its impacts and its mitigation. Because the study regions selected were semi-arid dry lands, the particular climate change impacts included drought; as a result the policy problem was climate change and drought. All institutions relevant to climate change (e.g. Nationally Determined Contributions), and drought (e.g. water rationing, building of hydroelectric dams), became a necessary part of the study.

Because adaptive governance has been developed in relation to closely interconnected human and biophysical systems across multiple scales, a territorial parameter of the system being studied in which the policy problem will be isolated should be made. The research to which this method applied was determined by the boundaries of a local watershed, allowing climate and hydrology data available on a watershed basis (developed by a team of climate change scientists in the interdisciplinary projects) to inform the study. Here, the case studies included selected communities in a watershed in Canada (the South Saskatchewan River Basin), Chile (the Elqui River Basin), and Argentina (the Mendoza River basin). See Appendix I for further detail on the case studies.

This research capitalizes on four interdisciplinary multi-year research projects that were conducted in Canada and South America exploring agricultural producers and their community, their vulnerability and adaptive capacity.[9] In addition to the literature and reports generated in these projects, a thorough review of secondary sources and literature was gathered relating to climate change, drought and the main driving forces and institutions affecting rural agricultural producers' livelihoods in the communities, relevant to building their capacity to respond to drought and climate change. In addition, forty one semi-structured qualitative interviews with key stakeholders in the four case study areas explored issues identified in this method including:

[7] The ESG Project research framework is advanced for multiple environmental sectors and intended as an inspirational programme possibly uniting multiple researchers and research programmes (Biermann et al., 2009).

[8] The problem of causality is addressed in defining the policy problem and appropriate institutions of study; the problem of performance in step four; and the problem of design in step six. Step two and three include analyzing institutions and instruments thereby examines the Architecture of the regime.

[9] These are: (1) SSHRC (Social Science Research Council of Canada) funded collaborative project between Canadian and Chilean researchers focused on institutional adaptations to climate change (IACC) (see http://www.parc.ca/mcri/). (268 interviews in Canada, and 86 interviews in Chile assessing the vulnerability and adaptive capacity of local agricultural producers; 100 Governance interviews in Canada and 30 in Chile). (2) A Saskatchewan drought project (see http://www.parc.ca/rac). (243 agricultural producer vulnerability interviews; 12 Governance interviews). (3) Deliberative democracy in the watershed project funded by SSHRC (see www.parc.ca/vacea/index.php/water-governance) (100 Local water advisory group interviews). (4) Vulnerability to Climate Extremes project funded by SSHRC, NSERC, and IDRC, with case studies in Canada, Chile, Argentina, Columbia and Brazil (see http://www.parc.ca/vacea/). (100 Agricultural producer vulnerability interviews; 70 governance).

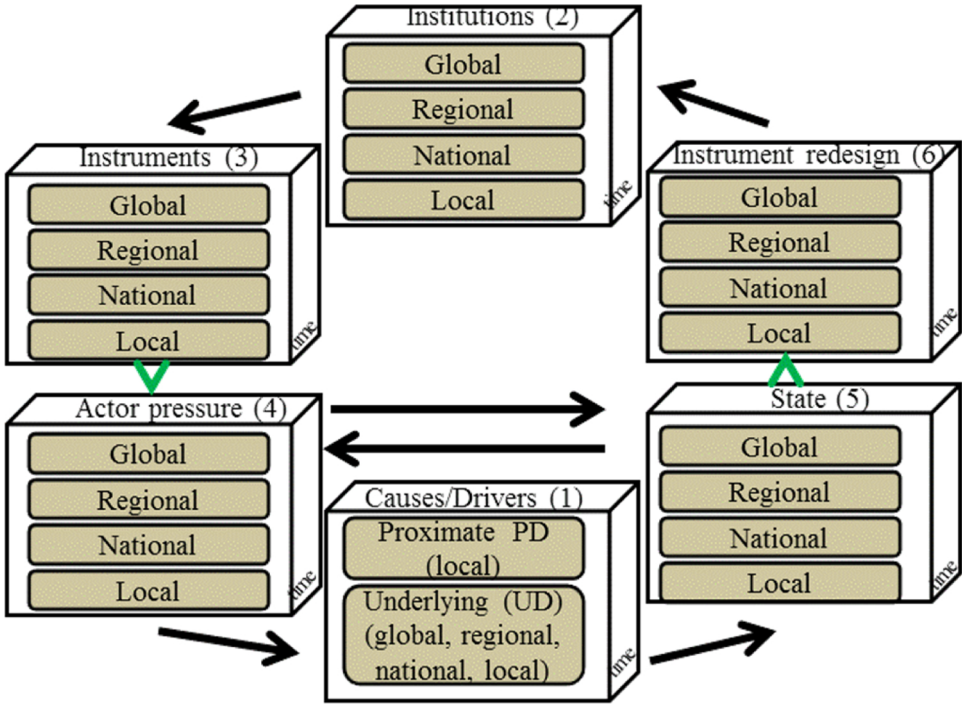

Fig. 1. Institutional Analysis Method for Adaptive Governance.
Source: Hurlbert, 2018; Young et al., 2005; IDGEC, 1989; Gupta et al., 2013.

Table 1
List of Steps in the Institutional Analysis Method for Adaptive Governance.
Source: Hurlbert, 2018

No	Step	Sub-step	
1	**Drivers**		**Identify drivers**: classify as direct/indirect; in terms of characteristics; administrative scale/level; and time frame (short versus long)
2	**Institutions**		**Identify institutions:** Amass the multi-level policy architecture considering all formal and informal practices, organizations, laws and policies
3	**Instruments**		**Identify, classify and analyse policy instruments and governance processes**
		a	Identify possible and existing policy instruments (formal/informal, state/non-state), categorize (regulatory, economic, management and suasive)
		b	Identify missing instruments and governance processes
4	**Actor pressure**		**Impact of instruments on actors in context of drivers**
			Assess actor perception of effectiveness of instruments at achieving purpose, given drivers
5	**State**		**Impact of actor pressure on state**
			Assess impact of policy instruments on livelihood capitals (human, social, ecological, economic, technological) of agricultural producers
6	**Instrument Redesign**		**Assess existence of institutional design principles of adaptive governance**
		a	Assess totality of governance system using adaptive capacity wheel
		b	Redesign instrument/instrument mixes (using information from steps 3-6)
		c	Devise method of engaging public in redesigning instruments

- Did instruments achieve their stated goals (were they effective)?
- What effect instruments had on the livelihood capitals (human, social, economic, technological, and natural) of agricultural producers in respect of drought in the study regions?
- How can policy instruments and institutions be redesigned to better build capacity for rural agricultural producers to respond to the increasing likelihood of drought?

3.1. Step 1: identifying the multi-level drivers of the problem

The first step of the analysis identifies the drivers or stressors, that are the causes of the problem being studied. Drivers are important as instruments need to address drivers and selection of policy instruments relates to the nature of drivers; ultimately drivers impact the effectiveness of instruments. Drivers might be human or natural induced circumstances that cause change in ecosystems either directly or indirectly and they could be due to demographic, economic, socio-political, cultural, religious, technical, biological, and physical factors (Nelson and Coauthors, 2006). These drivers are then analysed in terms of whether they are direct or indirect; how they can be characterized (social (demographic, political economy), environmental, technological, or economic) and at which global, national, or local scale/level they operate (Gupta et al., 2013).

In relation to agricultural producers and drought, specific drivers were found to include deteriorating ecosystems and concomitant loss of services, urbanization, as well as changing food prices (see Table 2). Where possible, a time frame for the drivers is also specified. The driver of climate change operates in the long term, and drought is immediate.

3.2. Step 2: identifying institutions: the multi-level policy architecture

The second step involves the identification of the pertinent organizations dealing with a specific problem, here climate change and drought. It requires a description of how organizations address the problem. The analysis is not limited to state institutions, but includes non-governmental and private organizations, or hybrid combinations of

Table 2
Drivers impacting agricultural producers in study areas.
Source: Hurlbert, 2018

Category	Direct		Indirect	
	Local	National (Global)	Local	National (Global)
Demographic	Lack of farm labour		Urbanization Population growth Aging producers	Global population increase reflecting gender inequality/poverty
Economic	Escalating land prices Oil and mining development		Aging infrastructure (roads and dams) Reduced size and budget of government	2008 world recession Currency fluctuations affecting food prices
Political Economy	Increasing cost of farm inputs	Reduction of government farm programs Monetary policy, inflation, lack of capital availability impacting cost of business		Growing inequality Increasing demand for energy increasing its price Reduced social supports
Social				Priority of economy over environment
Natural	Deteriorating ecosystems and concomitant loss of services		Drought	Climate change

Table 3
Organizations responding to climate change and drought.

Global	United Nations (UN), World Trade Organization, World Bank, United Nations Framework Convention Climate Change, Future Earth, UN Water, Salvation Army, Red Crescent and Red Cross		
	Study Area		
	Canada	Chile	Argentina
National	Ministry of Agriculture, Environment, Natural Resources Canada, Health, Fisheries and Oceans Ducks Unlimited, Canadian Water and Wastewater Association	General Directorate of Water (DGA) Hydraulic Works Authority (DOH) National Irrigation Commission (CNR)	Ministries of Environment, Economics, production? Public Works National Institute of Agricultural Technology
Inter-regional	Prairie Provinces Water Board Red Cross, Salvation Army, Watershed advisory committees	Climate Change Agri-Council	Transboundary River Committee Environmental Federal Council
Regional/ Provincial	Water Ministry/Agency Drought Committee Environmental groups		DGI? Agri-industry and Technology ministry General Water Users Assembly
Local-municipal	Municipalities, Irrigation districts, Local watershed groups, Agribusiness, mining companies	Municipalities, Juntas de Vigilencia, water communities, user associations (potable water, drainage, agricultural, groundwater), Agribusiness, mining companies, hydroelectric companies	Municipalities, Riverbed Inspectorates, Inspectors, Basin Councils, Popular Water Assembly, Irrigator cooperatives, multinational agricultural producers

(See Hurlbert, 2018 and Fletcher et al., 2012).

the above. The study of these institutions includes government ministries of agriculture, environment, fertilizer companies, and insurance companies, a selection of which appears on Table 3.

Since Young's institutional model does not explain how best one can assess the policy architecture, the Earth System Governance Science Plan (Biermann et al., 2009) recommendations are followed and the cross-cutting issues of norms and science inform the selection of the policy problem and delimitation of the system under study described above; the cross cutting issue of scale in influencing policy formulation is assessed in many of the steps depicted on Fig. 1. Scale is included in relation to national, inter-regional, regional or provincial, and local[10] as detailed in relation to drivers outlined above, and in relation to actors and policy instruments (national, provincial or local). There are many institutions and organizations at the global level in relation to climate change related to climate change and drought. A content analysis revealed at the global level, a strong institutional response to climate change and a highly dense organizational network in relation to disaster risk reduction.

The cross cutting issue of power is analyzed through a combination of this step, to and including step five. Conclusions regarding the use of power can be derived starting in this step to and including step five. Power is described based on the perceptions of the key stakeholders interviewed, as power is key in understanding the dynamics of institutions. Power is defined as getting one's way (through such things as possession of resources, ability to persuade, and control of others' response (Egan and Chorbajian, 2005). In this research issues of power arose in relation to the enforcement, or non-enforcement in all case study areas, of policies such as water licensing, quotas, and GHG limiting regulations. Another example includes the existence of strategies for climate mitigation, but the lack of instruments implementing the strategy. Lastly, the perceptions of interviewees informed power conclusions about accountability and transparency of water property or license governance Fig. 2.

[10] In the case studies in this research local referred to organizations operating within the specific case study area of the river basin and its towns, cities or communities, provincial or regional referred to the organizations within the province of Mendoza, Saskatchewan and Alberta (Chile not having this level of government is left blank), and inter-regional organizations operated across more than one province, state was the national government, and global organizations operated with the involvement of states or across several states.

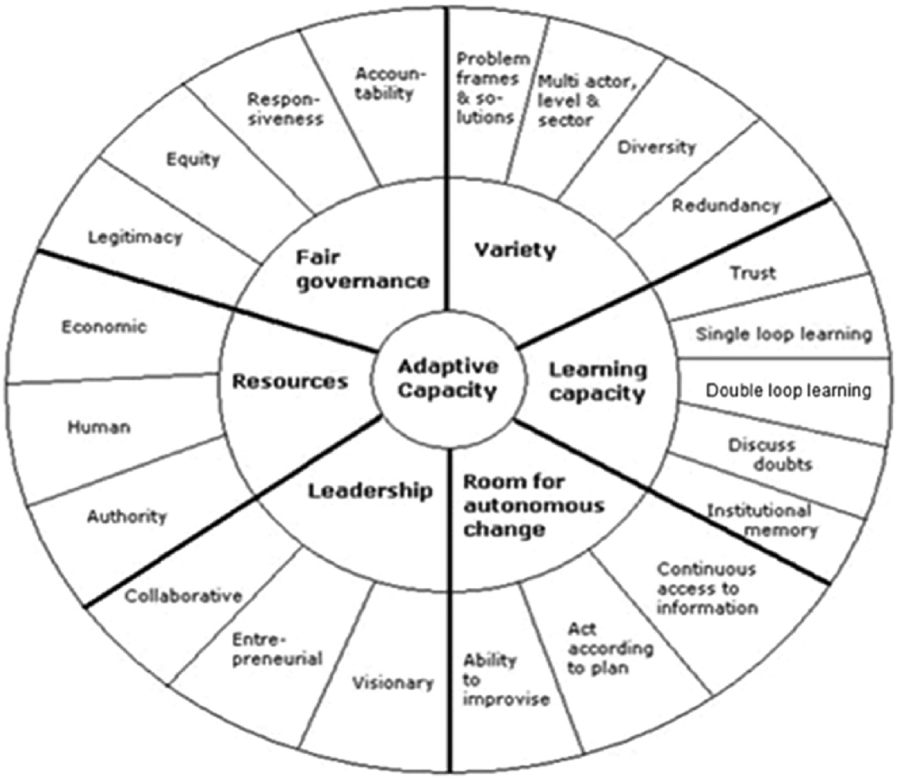

Fig. 2. Adaptive capacity wheel.
Source: Gupta et al., 2010.

3.3. Step 3: Identify, classify and analyze instruments and governance processes

The third step requires the (3a) identification of policy[11] instruments that are expected to lead to changed behaviour of social actors or the specific operational instruments promoted by the organizations identified in step two. Policy instruments are designed by state or non-state actors to influence behaviour and affect a person to do things, refrain from doing things, or continue doings things (Anderson, 2010) and include regulatory, economic and market-based, suasive, and managerial or other instruments (Gupta et al., 2013: 45; outlined in Table 4).

Table 4 reflects the initial definition of the policy problem and system under study. For instance, regulatory instruments responding to climate change include GHG mitigation measures such as carbon reduction requirements for coal fired power production facilities, or gasoline emission standards. In relation to the case of agricultural producers affected by droughts, embedded policy problems include agricultural producer income insecurity due to the driver of variable production (resulting from drought) and sales price fluctuations. An instrument such as crop insurance allows agricultural producers to adapt to climate variability including droughts.

Table 5 provides a selection of instruments responding to climate change and drought in the case study areas (identified by ethnographers determining the vulnerability of agricultural producers through interviews and documentary analysis of the organizations identified in step two). Although strong global organizations were identified in relation to climate change and drought (step two), there was no evidence of the application of global instruments at the local, regional, or national level of the case study areas. In Canada, many institutions and instruments responded to drought and only a handful addressed climate change effectively. Many drivers (including urbanization and aging of agricultural producers) did not have instruments addressing them. Few instruments facilitate public participation. In the developing countries the multi-level institutional system and its instruments are fragmented. The state governments are weak; development tends to exclude producers without water rights. In Chile local governments respond to drought without support from the central government. They lack instruments dealing with producer vulnerability (e.g. bankruptcy and insolvency instruments, human rights for drinking water, accessible financial aid for small and medium producers) and the privatized water market takes many policy problems outside the purview of the state. Chile's irrigation instruments, in combination with the water market, have increased the economic capital of large powerful producers. The case study areas frame climate change and drought as two disjointed wicked problems. As a result, there are few instruments capable of enhancing the capacity of producers to deal with climate change and extended drought.

The second part of this analysis (3b) assesses how the current instrument combination of the specific case study compares with the range of possible instruments addressing climate change and drought emerging from a literature analysis (Mwinjaka et al., 2010) and how the range of adaptive governance management instruments are utilized, or not (see Table 5 on the row marked 'missing instruments'). The analysis also looks at what kinds of instruments and policy processes have been predominantly used and why, thereby engaging in the underlying norms and discourses in a society, and how these have shaped policy processes.

[11] A policy is defined as a "course of action or principle adopted or proposed by a government, party, business or individual" (OECD, 2012: n.p.).

Table 4
Policy instruments as applied to climate change and drought.
Source: Hurlbert, 2018

Instrument types	Description	Level	Examples
Regulatory	Ensure compliance through legislated command and control	Local, provincial, national, regional, global	GHG reductions Water licence
Economic	Financial, market (creation or employment)		Insurance Water market
Suasive	Enhancing individual decision making by encouraging internalizing resilient environmental behaviour		Best management practices to prevent soil erosion, conserve water, prevent water quality problems
Management and adaptive governance processes	Voluntary management arrangements of NGOs, municipalities, civil society or private organizations Adaptive management Adaptive co-management Anticipatory governance		Local watershed planning committees Irrigator associations Participatory climate change planning through scenario mapping

Table 5
Selected Instruments Responding to climate change and drought in case studies.

Instrument	Case study	Water/climate change	Effectiveness	Drought	Effectiveness
Regulatory	All	Water pollution control/quality standards	+		
		Waste water treatment controls	+		
		Land use restrictions	–		
	Canada	GHG reductions (industry and sector specific)	–	Licence quotas for water allocations/ permits	+
	Chile	Fines for illegal water extraction	–	Water rationing (Truro)	–
		Reversion of unused water allocations	–	Ecological flow restriction	–
	Argentina	Glacier Preservation Law	+	Degradation target of UNCCD	–
		Fee for non-use	–		
Missing	Pervasive GHG reduction measures, Berlin Rules on Water Resources, Human right to water and sanitation, Climate Change 1.5 to 2 degree target, climate change lawsuits, right to be free from climate change damage				
Management	All	Water attaching to land and managed by owners as common property	+	Hyogo Framework for Action	+
		Local water governance (irrigation)	+	Risk management tools	+
	Canada	Source water protection plans	+	Insolvency	+
		Boundary Water Treaty	+	Drought Strategy	+
		Integrated Water Plan	–	Integrated land use management and planning	–
				Public participation in water strategy, planning	–
				Local watershed plans	+
	Chile			National irrigation policy	+
	Argentina	Water registry		Public participation in water	+
Missing	Long term water management plans on integrated basis, proactive community planning for water shortaes, demand management of water, Integrated water resource management, community disaster planning for resilience, Indicators, Hyogo Framework Hazards of Place DRR tools, Long term conselling support services post flood disaster, Inclusive participatory development				

(For a more complete table see Hurlbert, 2018).

What existed in the case study was compared to what was available based on a review of the literature to identify missing instruments. Because several case studies were chosen (Chile, Argentina, and Canada) comparison of instruments and suites of instruments between case studies could also be made to identify missing instruments. One of the main findings of the study was that in Canada climate change had few policy instruments specifically addressing it, especially enduring iterative instruments involving public participation.

3.4. Step 4: Policy effects on actors – effectiveness of instrument at achieving goals

The fourth step is an analysis of the effectiveness of instruments at achieving their goals (mitigating climate change, stabilizing income of agricultural producers at times of drought etc.). This assessment was made based on the perceptions of people interviewed and a literature review. For instance, many economic studies measured the effectiveness of water markets at creating an efficient water market and contributing to Gross Domestic Product. If interviewees believe instruments are effective in achieving their planned goals, or if secondary literature documented the effectiveness of the instruments, a rating of (++) is achieved; some indication of effectiveness achieves a (+) rating, instruments with no effect a (0), and instruments that are counter-productive a (-) or (–) rating. This rating appears in Table 5 in the column marked 'effectiveness' next to each instrument (and is used again in steps 5 and 6).

The assessment of effectiveness is made in the context of the drivers. In Chile, certain water laws and regulations to be applied by Juntas were applied differently in different locations because of resource and knowledge discrepancies (Hurlbert and Diaz, 2013). The driver of reduced government spending caused lack of resources and resulting lack of knowledge in some areas. In Canada federal government climate skepticism was a driver resulting in an absence of effective policy mitigating climate change (when data was gathered in 2012). The purpose of identifying the drivers is to understand how to design an instrument that addresses the driver, or causes of a problem and not the symptoms.

Clearly such a system of assessment can be made more complex if time and resources permit. For example, the effectiveness of the

Table 6
Selected instruments positively impacting livelihood capitals of agricultural producers.
Source: Hurlbert, 2018; Based on De Haan and Zoomer 2005[a].

Instruments	Capitals	Description
Farm Ranch Water Infrastructure program (Canada)	Technological/ productive/ physical capital	Access to productive agricultural technology including irrigation equipment, soil erosion prevention techniques, farm machinery, etc.
Red Cross/Crescent Disaster Assistance contracts	Human	Education, skills, experience, knowledge, creativity, inventiveness, and health
Loan instruments, Agriculture income stability programs, Insolvency management instruments	Economic	The financial resources available to people (savings, supplies of credit)
Local watershed governance, irrigation association management	Social	The quality of relations among people, or the groups, networks, norms and trust people have available to them for productive purposes. Includes social relations, formal, informal networks, group memberships that allow bonding (ties to similar people) and linking (to those in authority)
Payment for ecosystem services	Natural/ecological (including ecosystem services)	The stock of environmentally provided assets such as soil, forests, minerals, water and wetlands and the ecosystem services provides by such stocks – namely supporting, provisioning, regulating and cultural.

[a]The literature identifies the various capitals necessary with much commonality and minor differences. One source lists them as physical, financial, human, social, and natural (Moser and Satterthwaite, 2008), and another as produced, natural, human, social, and cultural (Bebbington and Perreault, 1999). The determinants identified by the IPCC (2001) are economic wealth, technology, institutions, information and skills (human), economic wealth, infrastructure, and equity.

instrument may need to be gauged in relation to a range of specific policy goals, where some are achieved and some not. In our study the stabilization of agricultural producer income over several years was effectively achieved by a suite of instruments crossing regulatory (water licensing), economic (water infrastructure grants), suasive, (drought prediction and alerts), and management categories (local watershed plans)(Hurlbert and Gupta, 2016).

3.5. Step 5: Impact of policy instruments on livelihoods of agricultural producers

The fifth step of the analysis requires an analysis of the effects of instruments, given drivers, on the livelihood capitals (human, social, economic, technological, and natural) of local people (see Table 6). Do the instruments improve, or detract from agricultural producer human, social, economic, technological or natural capital that allows them to adapt to climate change (IPCC, 2001), build resilience (Moser, 2009), and earn a livelihood (de Haan and Zoomer, 2005d)? Table 6 defines and explains these capitals in relation to the case of agricultural producers. In this analysis, the focus was on local people, but clearly this analysis can also be scaled up to examine impacts at national and regional levels.

Instruments are assessed as either (-, –) negatively impacting livelihood capital, neutral (0), or (+, ++) positively impacting capital. Data used in this analysis include the secondary sources reviewed (such as the work of economists assessing the efficiency of the water market in Chile), the vulnerability analysis of the ethnographers involved in the project, and the perceptions of key stakeholders interviewed. Several select instruments identified as increasing capitals are shown on Table 6.

Technological capital was advanced by Canada's Farm and Ranch Water Infrastructure program that encouraged mitigation of the effects of drought through construction of such things as community wells, shallow or deep buried pipelines and dugouts, all eligible for shared funding from provincial and federal governments (Hurlbert, 2018; Hurlbert and Pittman, 2014). In Chile the national irrigation plan advanced technological as well as economic capital for large, capital intensive viticulture operations (Hadarits et al., 2016). **Human** capital was improved by access to agricultural advisory services. In all study areas crop insurance increased **economic** capital as well as programmes in the study areas that increased irrigation efficiency, allowed trading of water rights temporarily, provided off-farm employment, and enabled cooperation between people, communities and governments during times of disaster. Canada's insolvency policy instruments that allowed bankruptcy while protecting home quarters and basic income allowed for a transition to another livelihood advancing economic capital (Hurlbert, 2018). Local watershed and irrigation governance in all study areas advanced **social** capital and improved the adaptive capacity to climate change and drought. **Natural** capital was advanced in Canada through a programme of farm stewardship assisting producers in environmental farm practices to prevent soil degradation and in Argentina with a Glacier Protection Law that effectively prevented mining in the Andes that might damage the glacier and impact the water of the Mendoza river (Hurlbert, 2018; Hurlbert and Pittman, 2014).

3.6. Step 6: instrument redesign

Although the original Young framework moved straight to analyze how to improve the instruments, given their contextual effectiveness, here the sixth step has three parts. First, in 6(a), the totality of the governance system (determined by the previous steps) is assessed using the adaptive capacity wheel (ACW) of Gupta et al. (2010, 2016) in order to identify dimensions of institutional adaptive capacity that need to be addressed. The formal institutions (organizations and instruments) and informal institutions (practices and behaviours evidenced by effectiveness of instruments and impact on livelihood capitals) are ranked at an aggregate level using the qualitative assessment tool, the ACW (Hurlbert and Gupta, 2015; Klostermann et al., 2010).

The ACW is composed of six dimensions of adaptive governance including variety (of instruments, perceptions, actors), learning capacity, room for autonomous change, leadership, resources, and fair governance (with 22 sub-criteria) (Gupta et al., 2010) (see Fig. 2). Here, green reflects high rankings (++, enhancing adaptive capacity), light green rankings indicate lack of comprehensive institutions (+), yellow have no impact (0), light orange indicate that there are gaps that require filling (-), and red reflect institutional obstacles to adaptation (–) (Klostermann et al., 2010). These rankings are derived from a content analysis of formal and informal policy documents, data obtained in the previous steps, and interviews of key stakeholders in the governance system.

While Chile and Argentina had lower scores in relation to dimensions of resources, fair governance and variety, it was based on significant barriers faced by small and medium producers in trade (accessing regional and international markets) and the inability of those

without water licenses to participate in water governance. All case studies had issues of equity and fair governance as a growing spread is occurring between large and small agricultural producers and all need more iterative public engagement instruments in relation to climate change and drought. These instruments may also have co-benefits in relation to learning advancing both human and social capital.

The second part of redesign (6b) is to identify a policy and instrument strategy, a theoretical step that is undertaken as follows:

a) Adopt effective instruments where appropriate, disband ineffective instruments (or redesign them in order that they become effective) and implement appropriate missing instruments. Effective instruments were found to include crop insurance, bankruptcy and insolvency, involvement of community in co-management of water and disaster planning;
b) Create instruments for unaddressed drivers (climate change, global market trends, financial capital trends, government austerity, aging agricultural producers, growing inequality, changing size of farms, urbanization, increasing demand for energy and aging infrastructure);
c) Create instruments to implement the environmental governance approaches of adaptive management (hypothesis testing), anticipatory governance (public engagement utilizing climate scenario planning), or adaptive co-management (extensive public participation in relation to resource management to achieve inclusive development) in relation to drought. These were seldom found in the case studies;
d) Address the lowest ranking of the dimensions of adaptive capacity on the ACW identified that included resources, accountability and advancement of learning.

The third part of redesign (6c) is the confirmation and reassessment of data generated in steps 3 through 5 with stakeholders (those with experience in agriculture, climate change, drought and flood management) and the public. Adaptive governance involves participation of people to address uncertainty and promote social learning (Pahl-Wostl et al., 2007) and specific processes of participation included in collaborative governance (Plummer, 2009) and anticipatory governance (Quay, 2010). This step is the final part of the research project as climate change science and findings concerning livelihood capitals and policy instruments are reviewed with agricultural and policy communities to develop an instrument redesign strategy.

4. Assessment of the method

Different aspects of the institutional analysis method for adaptive governance have already been tested in a series of papers. Institutional design principles and the Adaptive Capacity Wheel are heavily used in the literature.[12] The strength of this integrated method is how it highlights the need to adapt to continuous change and adds cross-cutting issues recommended by the Earth System Governance project (see Pahl-Wostl et al., 2013) and the ACW. The assessment of instruments on livelihood capitals allows for a deeper analysis than just the effectiveness of instruments on actors and society given drivers as it allows for a comprehensive consideration of the resilience of people. It provides clear outcomes to measure in relation to adaptive governance (effectiveness, livelihood capitals, ACW dimensions). The totality of this information can inform instrument redesign and be contextualized in relation to appropriateness by including participation in policy making by people.

The challenge of the method is it complexity. The number of organizations, laws, policies and instruments relating to complex problems are substantial. Performing a content analysis, and conducting targeted interviews is very labour intensive. Each step of the analysis requires a reconsideration of secondary sources, content analysis, and interviews to answer the research question involved in the analysis. However, tackling unstructured, complex, systemic problems such as climate change and drought is complex (Pahl-Wostl et al., 2013). It was difficult to isolate the effect of individual mechanisms and instruments on the environment and livelihoods. Interviewees occasionally had difficulty drawing direct connections and conclusions.

In order to improve understanding of local contextual drivers (e.g. the unenforceability of water licenses) a determination of accountability could be added in step 3(a). Here it could be determined if accountability is provided for in the design of the instrument. By assessing this within secondary sources, the matter can be clarified during interviews, if need be, and then the data can inform findings surrounding accountability within the ACW assessment of Step 6. This focused analysis will improve the robustness of the data and refine the analysis and assessment.

5. Conclusions

This paper has outlined a method based on new institutionalism and IHDP/IDGEC's institutional analysis framework of Young et al. (2005), the multi-level governance theory of Future Earth's ESG Project (Biermann et al., 2009), and the multi-level institutional analysis developed by Gupta et al. (2013). Added to this method were concepts of livelihood capitals (Moser, 2009), ACW (Gupta et al., 2010), and participation (Auth and Auth, 2015). An institutional research analysis method for adaptive governance developed herein addresses a weakness in adaptive governance literature in relation to the specific methods for the application and assessment of policy instruments advancing adaptive governance.

Effective instruments identified included bankruptcy and insolvency, co-management of community in water and disaster planning, and combinations of instruments delivering co-benefits and building agricultural producer livelihoods such as crop insurance, income stability, water infrastructure programs, environmental farm practices preserving soil resilience. Unaddressed drivers warrant instruments such as mitigation of climate change and financial capital trends and more instruments iteratively consulting with communities concerning the risk of drought and climate change are needed, all of which will improve dimensions of adaptive governance.

Based on the application of this method (Hurlbert and Gupta, 2016; Hurlbert, 2018) the successes, challenges, and improvements of the method are discussed. The method is challenging because it deals with a complex problem and uses multiple methods (redundancy) as a way to ensure that the results are robust. Causality of impacts remain difficult to identify in a neutral manner, but the qualitative assessment leads to key messages about how policy instruments can be improved. This diagnostic, institutional method contributes to usable knowledge regarding how policy problems can be addressed; it goes beyond simple quantitative analysis to provide a rich critical review of current policy processes in order to promote adaptive and inclusive governance.

Acknowledgments, Samples, and Data

This manuscript is a work product of the collaborative project, Vulnerability and Adaptation to Climate Extremes in the Americas (VACEA), is one of 5 international initiatives funded through the International Research Initiative on Adaptation to Climate Change

[12] Young's institutional analysis model (eg. Vatn and Vedeld, 2012). Problem structuring has been used in the policy literature (Hoppe, 2011) and adaptive governance is a very strong emerging theme (Folke et al., 2005), Adaptive governance of social-ecological systems. Annual Review of Environmental Resources. 30, 411-473." Folke et al., 2005). Livelihoods analysis is very common in development studies literature (Moser, 2009). Risk and policy framing is elaborated in Hurlbert and Gupta (2016) and participation and policy framing and adaptive governance in Hurlbert and Gupta (2015).

(IRIACC) by the International Development Research Centre (IDRC) and the Canadian Tri-Council research funding agencies (NSERC, SSHRC, and CIHR).

Neither of the authors have any real or perceived financial conflicts of interests.

Appendix I

Details of Case Studies, 2018 Details of Case Studies

The research was carried out in three study areas: Canada, Chile, and Argentina. All case study areas are glacier fed, dry land riverbeds, with some irrigation and experience with drought. All study areas have very disparate governance structures, especially in relation to water (a fundamental system in relation to drought). These differences allowed for comparison of institutional practices. More detail appears on the table below.

River basin, country	Location	Agricultural production	Droughts	Irrigated agriculture	Population
Mendoza, Argentina	Eastern Andes	Irrigated agriculture, fruits, horticulture, cattle, goats	1968, 2010-2014	Approximately 3% of the surface is irrigated; goat husbandry on the rest	1.28 million
Elqui, Chile	Western Andes	Irrigated agriculture, fruits, cattle, goats	2003, 2007, 2012-2015	Irrigated agriculture on a small percentage and goat husbandry	386,000
South Saskatchewan River Basin	Southern Alberta and Saskatchewan	Irrigated agriculture, pulses, forage, vegetables, cattle	1998, 2001-2002, 2011	80,186 of 205,730 Canadian Farms are in Saskatchewan and Alberta	1,82 million in the study communities in (Oldman, Swift Current)

(Auth 2018)

References

Anderson, J.E., 2010. Public Policymaking: an Introduction. Cengage Learning, Hampshire UK.

Bebbington, A., Perreault, T., 1999. Social capital, development, and access to resources in Highland Ecuador. Econ. Geogr. 75 (4), 395–418. https://doi.org/10.2307/144478.

Berkes, F., Folke, C. (Eds.), 1998. Linking Sociological and Ecological Systems: Management Practices and Social Mechanisms for Building Resilience. Cambridge University Press, New York, New York, USA.

Biermann, F., Betwill MM, Gupta J, Norichika K, Lebel L, Liverman D, Schropeder H, Siebenhuner B, with contributions from Conca, K., da Costa Ferreira L, Bharat D, Tay S and Zondervan R (2009), Earth System Governance: People, Places and the Planet. Science and Implementation Plan of the Earth System Governance Project. Earth System Governance Report 1. IHDP Report 20. Bonn, IHDP: The Earth System Governance Project.

Bracken, L.J., Oughton, E.A., 2006. The importance of language in developing interdisciplinary research. Transactions. 31 (3), 371–382.

Brewer, G.D., 1999. The challenges of interdisciplinarity. Policy Sci. 32, 327–337.

Buizer, M., Arts, B., Kok, K., 2011. Governance, scale and the environment: the importance of recognizing knowledge claims in Transdisciplinary Arenas. Ecol. Soc. 16 (1).

Carroll, N.E., 1988. Philosophical Problems of Classical Film Theory. Princeton: Princeton University Press.

de Haan, L., Zoomer, A., 2005d. Exploring the frontier of livelihoods research. Dev. Change 36 (1), 27–47.

Dietz, R., Ostrom, E., Stern, P.C., 2003. The struggle to govern the commons. Science. 302 (5652), 1907–1912.

Dwyer, J., Hodge, I.D., 2016. Governance structures social ecological systems. Environ. Sci. Policy 66, 1–10.

Egan, D., Chorbajian, L.A., 2005. *Power, A Critical Reader*. Upper Saddle River. Pearson, New Jersey.

Fletcher, A., et al., 2012. Water Governance Institutions in the South Saskatchewan River Basin. Report Prepared for the Project Entitled 'Vulnerability and Adaptation to Climate Extremes in the Americas' University of Regina. Available from:. [Accessed 21 September 2014]. www.parc.ca.

Folke, C., Hahn, T., Olsson, P., Norberg, J., 2005. Adaptive governance of social-ecological systems. Annual Review of Environmental Resources. 30, 411–473.

Folke, C., 2016. Resilience. subject: framing concepts in environmental science. Oxford research encyclopedia of enviornmental science. Oxford press. USA. https://doi.org/10.1093/acrefore/9780199389414,013.8.

Foxon, R., Reed, M.S., Stringer, L.C., 2009. Governing long-term social-ecological change: What can the adaptive management and transition management approaches learn from each other? Environ. Policy Gov. 19, 3–20.

Gitlin, T., 1980. The Whole World Is Watching: Mass Media in the Making and Unmaking of the New Left. University of California Press. Berkeley, CA, USA.

Gupta, J., ven der Grijp, N., Kuik, O. (Eds.), 2013. Climate Change, Forests and REDD: Lessons for Institutional Design. Routledge Publishers.

Gupta, J., et al., 2010. The adaptive capacity wheel; a method to assess the inherent characteristics of institutions to enable the adaptive capacity of society. Environ. Sci. Policy Sustain. Dev. 13, 459–471.

Gupta, J., Bergsma, E., Termeer, C.J.A.M., Biesbroek, G.R., van den Brink, M., Jong, P., Klostermann, J.E.M., Meijerink, S., Nooteboom, S., 2016. The Adaptive Capacity of Dutch Institutions in the Dutch spatial planning, water, agriculture and nature sectors. Mitig. Adapt. Strateg. Glob. Chang. 21, 883–903. https://doi.org/10.1007/s11027-014-9630-z.

Hadarits, M., Santibanez, P., Pittman, J., 2016. Drought risks and opportunities in the Chilean grape and wine industry: a case study of the maule region. chapter 13 In: Diaz, H., Warren, J., Hurlbert, M. (Eds.), Vulnerability and Adaptation to Drought: The Canadian Prairies and South America. Alberta: University of Calgary Press, Calgary, pp. 303–326 ISSN 1919-7144.

Hisschemöller, M., Gupta, J., 1999. Problem-solving through international environmental agreements: the issue of regime effectiveness. Int. Political Sci. Rev. 20 (2), 151–174.

Hisschemöller, M., Hoppe, R., 1996. Coping with intractable controversies: the case for problem structuring in policy design and analysis." knowledge and policy. Int. J. Knowl. Transfer Util. 8 (4), 40–61.

Homer-Dixon, T., 1999. Environment, Scarcity, and Violence. Princeton: Princeton University Press.

Hoppe, R., 2011. The Governance of Problems, Puzzling, Powering and Participation. University of Bristol. The Policy Press, Bristol.

Howlett, M., 2011. Designing Public Policies. Principles and Instruments. Routledge, London and New York.

Hurlbert, M., Gupta, J., 2016. Adaptive governance, uncertainty, and risk: policy framing and responses to climate change, drought, and flood. Risk Anal. 36 (2), 339–356. https://doi.org/10.1111/risa.12510.

Hurlbert, M., 2018. Adaptive Governance of Disaster: Drought and Flood in Rural Areas. Springer, Cham, Switzerland.

Hurlbert, M., Gupta, J., 2015. The Split Ladder of Participation: a diagnostic, strategic, and evaluation tool to assess when participation is necessary. Environ. Sci. Policy 50, 100–113.

Hurlbert, M., Pittman, J., 2014. Exploring adaptive management in farm programs in Saskatchewan. J. Nat. Resour. Policy Res. 6 (2-3), 195–212. https://doi.org/10.1080/19390459.2014.915131.

Hurlbert, M., Diaz, H., 2013. Water Governance in Chile and Canda- a comparison of adaptive characteristics. Ecol. Soc. 18 (4), 61–76.

IDGEC, 1998. (Institutional Dimensions of Global Environmental Change). Science Plan for the project on the Institutional Dimensions of Global Change Available at: ibm.rhrz.uni-bonn.de/IHDP/IDGCsp.htm.

IPCC, 2001. Climate change 2001: impacts, adaptation, and vulnerability technical summary, a report of working group II of the intergovernmental panel on climate change 2001, intergovernmental panel on climate change, WMO and UNEP. Geneva.

IPCC, 2014. Summary for policymakers. In: Edenhofer, O., Pichs-Madruga, R., Sokona, Y., Farahani, E., Kadner, S., Seyboth, K., Adler, A., Baum, I., Brunner, S., Eickemeier, P., Kriemann, B., Savolainen, J., Schlömer, S., von Stechow, C., Zwickel, T., Minx, J.C. (Eds.), Climate Change 2014, Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Jiménez Cisneros, B.E., Oki, T., Arnell, N.W., Benito, G., Cogley, J.G., Döll, P., Jiang, T., Mwakalila, S.S., 2014. Freshwater resources. In: Field, C.B., Barros, V.R., Dokken, D.J., Mach, K.J., Mastrandrea, M.D., Bilir, T.E., Chatterjee, M., Ebi, K.L., Estrada, Y.O., Genova, R.C., Girma, B., Kissel, E.S., Levy, A.N., MacCracken, S., Mastrandrea, P.R., White, L.L. (Eds.), Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 229–269.

Klostermann, J., Bergsma, E., Gupta, J., Jong, P., 2010. Applying the Adaptive Capacity Wheel On the Background Document Of The Content Analysis. ICI2 Institutions for

Adaptation, Working Document 5. IVM Institute for Environmental Studies, Amsterdam.
Lascoumes, P., Le Gales, P., 2007. From the nature of instruments to the sociology of public policy instrumentation. Governance, Understanding Public Policy through its Instruments 20 (1), 1–21.
Lebel, L., Grothmann, T., Siebenhuner, B., 2010. The role of social learning in adaptiveness: insights from water management. Int. Environ. Agreem. 10, 333–353.
Matthews, L.G., Jones, A., 2008. Using systems thinking to improve interdisciplinary outcomes. Issues in Integrative Studies 26, 73–104.
March, J.G., Olsen, J.P., 2011. Elaborating the New institutionalism. In: Ed, Goodin (Ed.), The Oxford Handbook of Political Science. Oxford University Press, Oxford, UK.
March, J.G., Olsen, J.P., 1984. The new institutionalism: organizational factors in political life. Am. Polit. Sci. Rev. 78 (3), 734–749.
Moser, S., 2009. Governance and the art of overcoming barriers to adaptation 3, 31–36.
Moser, C., Satterthwaite, D., 2008. Towards pro-poor adaptation to climate change in the urban centres of low- and middle-income countries. Human Settlements Discussion Paper Series Theme: Climate Change and Cities – 3. International Institute of Environment and Development (IIED), paper presented for the World Bank's Social Development Department Workshop on the "Social Dimensions of Climate change" held on March 5. 6 2008 at the World Bank, Washington, D.C.
Mwinjaka, O., Gupta, J., Bresser, T., 2010. Adaptation strategies of the poorest farmers in drought prone Gujarat. Clim. Dev. 2, 346–363.
Nelson, G.C., Coauthors, 2006. Anthropogenic drivers of ecosystem change: an overview. Ecol. Soc. 11. https://doi.org/10.5751/ES-01826-110229.
Norgaard, R.B., Liu, X., 2007. Market governance failure. Ecol Economics. 634–641.
Oberthür, S., Gehring, T., 2006. Institutional Interaction in Global Environmental Governance. Synergy and Conflict Among International and EU Policies. MIT Press, Cambridge, Mass.
OECD, 2012. OECD Environmental Outlook to 2050: The Consequences of Inaction. OECD Publishing, Paris Available at: https://doi.org/10.177/9789264122246-en Accessed 15 June 2015.
Olsson, P., Gunderson, L.H., Carpenter, S.R., Ryan, P., Lebel, L., Folke, C., Holling, C.S., 2006. Shooting the rapids: navigating transitions to adaptive governance of socio-ecological systems. Ecol. Soc. 11 (1), 1–18.
Ostrom, E., 2010. The institutional analysis and development framework and the commons. Cornell Law Rev. 95 (4), 807–816.
Ostrom, E., 1990. Governing the Commons: The Evolution of Institutions for Collective Action. Cambridge University Press, Cambridge, UK.
Paavola, J., 2007. Institutions and environmental governance: a reconceptualization. Ecol. Econ. 93–103.
Paavola, J., 2016. Multi-level environmental governance: exploring the economic explanations. Environ. Policy Gov. 26 (3), 143–154.
Pahl-Wostl, C., Giupponi, C., Richard, K., Binder, C., Shervinin, A., Sprinz, D., Toonen, T., van Bers, C., 2013. Transition towards a new global change science: requirements for methodologies, methods, data and knowledge. Environ. Sci. Policy 28, 36–47.
Pahl-Wostl, C., 2007. Requirements for adaptive water management. Pp 1-22. In: Pahl-Wostl, C., Kabat, P., ltgen, J. (Eds.), Adaptive and Integrated Water Management. Coping With Complexity and Uncertainty. Heidelberg: Springer Verlag.
Plummer, R., 2009. The adaptive Co-management process: an initial synthesis of representative models and influential variable. Ecol. Soc. 14 (2) online. http://www.ecologyandsociety.org/vol14/iss2/art24/.
Quay, R., 2010. Anticipatory governance, a tool for climate change adaptation. J. Am. Plan. Assoc. 76 (4), 496–511.
Ranganathan, J., Munasinghe, M., Irwin, F., 2008. Policies for sustainable governance of global ecosystem services. Edgar Elgar: Cheltenham, UK.
Repko, A.F., Szostak, R., 2017. Interdisciplinary Research Process and Theory, 3rd edition. Sage Publications, Thousand Oaks, California.
Rittel, H.W.J., Webber, M.M., 1973. Dilemmas in a general theory of planning. Policy Sci. 4, 155–169.
Roy, E.D., et al., 2013. The elusive pursuit of interdisicplinarity at the human – environment interface. Bio Science. 63 (9), 745–753.
Sabel, C.F., Zeitlin, J., 2012. Transformative cornerstones of social science research for global change. International Social Science Council, Paris.
Schmidt, V., 2011. Discursive institutionalism. Crit. Policy Stud. 5 (2), 106–126.
Scoones, I., 2009. Livelihoods perspective and rural development. J. Peasant Stud. 36 (1), 171–196.
Siebenhuner, B., 2008. Learning in international organizations in global environmental governance. Glob. Environ. Polit. 8 (4), 92–116.
Stangor, C., 2010. Research Methods for the Behavioural Sciences. Cengage Learning.
Tudela, A., Akki, N., Cistemas, R., 2006. Comparing the output of cost benefit and multi-criteria analysis. An application to urban transport investments. Transport Re Pol Pract 40, 414–423.
Vatn, A., 2005. Institutions and the environment. Edgar Elgar. Germany.
Vatn, A., Vedeld, P., 2012. Fit, interplay, and scale: a diagnosis. Ecol. Soc. 17 (4), 12–34.
Young, O.R., 2002. The Institutional Dimensions of Environmental Change: Fit, Interplay and Scale. MIT Press. Cambridge, Massachusetts.
Young, O.R., et al., 2005. Science Plan. Environmental Change. Bonn: International Human Dimensions Programme on Global Environmental Change (IHDP).
Young, O.R., 2017. Governing Complex Systems. Social Capital for the Anthropocene. Massachusetts Institute of Technology, Massachusetts.